Transforming the World using Holograms

Aunsh Chaudhari
Student, Computer Engineering Department
Dwarkadas J. Sanghvi College of Engineering

Keval Lakhani
Student, Computer Engineering Department
Dwarkadas J. Sanghvi College of Engineering

Khushali Deulkar
Professor, Computer Engineering Department
Dwarkadas J. Sanghvi College of Engineering

ABSTRACT
This paper puts light on the technology of Holographic Projections. It examines the relevance of this technology in today's era and describes the process of production of holograms. The significance of holography is further elaborated upon through its various applications and possible future uses. An introduction to the Microsoft HoloLens provides an exciting account of an implementation of this wave of technology through it, serving as the first untethered holographic computer thereby doing what technology does best – making life easy.

General Terms
Holography, Holographic Projections

Keywords
Hologram, Autostereoscopy, Microsoft HoloLens

1. INTRODUCTION
Ever wondered what makes Tony Stark so cool? The answer is pretty simple - his role as the Ironman, some exquisite cars and ofcourse high-end technology. Today, lets concentrate on this wave of technology, Holography. Google defines this term as the study or production of holograms. It is the method to record patterns of light, which are reproduced as a three dimensional image called a hologram.

Imagine if you could pick articles from the newspaper and display them on your forty-six inch TV. One tap to pick, another to drop. That's the magic of Holography. Holographic projection technology is based on a technique first used in Victorian theaters across London in the 1960s. In this methodology commonly called Pepper's Ghost, the viewers could see the object involved through its reflection at an angled piece of glass [1]. Modern 3D holographic projection uses a holoprojector, which will project large scale, high-resolution images on different surfaces, focal distances with the help of a relatively small scale projection device.

Holography is used to display a fully three dimensional image of the subject. A hologram can also be seen without eyewear or headgear. This concept is called Autostereoscopy. Modern three dimensional display technologies such as holography are very efficiently used in medical diagnosis, weather forecast, advertising, animation, virtual reality and so forth.

In this paper, we have discussed the concepts of holography, how it works and its various applications including the new Microsoft HoloLens. In Section II, we talk about Holography, its need and importance. Further, in Section III, we discuss the basic concept behind implementing this technology and several applications today are reviewed in Section IV. Finally, in Section V, the future uses of holography are elaborated upon.

2. WHAT IS HOLOGRAPHY?
Holography is the science and practice of holograms.It is the result of an interference pattern formed between two light beams. Tracing this wave of technology historically, it was invented by a Hungarian scientist named Dr. Dennis Gabor in the 1940s. In its pure form, Holography requires the use of laser light for illuminating the object involved and to view the finished hologram. An advantage of holography is that microscopic detail of the subject can be reproduced in the resulting virtual object form. 3D holographic displays provide realistic images that are used as viable alternatives to previous solutions.

2.1 Need and Importance
Holography is a rapidly growing technology that can project large-scale, high-resolution images onto free space. The excitement and enthusiasm related to this applied science sprouted with the 3D movie craze and continues so on through various applications as well as the advent of virtual reality. Holography serves an important role of providing human cues of stereopsis, motion parallax and ocular accommodation thus improving upon understanding, realistic production and efficient 3D rendering.

Stereoscopic approaches for example, using polarized eyewear, headgear to view the holograms have been successful in the past but people generally do not like to wear equipment over their eyes[1]. This is where Holography steps in and differs from previous 3D imaging innovations. Through autostereoscopy, holograms can be viewed without the use of obtrusive equipment. Not only is this problem solved, but also this practical application can accommodate simultaneous viewing. Each individual could be viewing an autostereoscopic 3D image that is entirely different from the others viewing it. Another need for holography is the use of unobtrusive equipment combining manipulation and feedback of 3D objects in space. Making the virtual world more realistic and interactive is an objective achievable through this technology.

Holography has the potential of providing data storage too. Currently, high capacity data storage is dominated by magnetic and optical data storage. The advantage of holographic data storage is that it records information throughout the volume of the medium and it can also record multiple images in the same area by utilizing light at different angles. While magnetic and optical storage devices record data in a linear fashion, this type of data storage records and reads millions of bits in parallel. As a result, holographic data storage has higher data transfer rates than the traditional methods. The changes brought about by holography are summarized and stated in Table 1.

Table 1. The effect of holography

Before	After
Costly and clumsy data storage	Faster, efficient data storage
Insufficient for comprehension	Detailed 3D rendering
Equipment necessary	No eye wear or headgear – autostereoscopy
Sufficient for viewing	Viewing, interaction and feedback accommodated
Single person viewing	Single and audience viewing possible

3. HOW IT WORKS

In 3D movies, the concept of stereoscopic 3D is in place. While it does give a sense of depth, it does not give parallax i.e. if you move your head around, the view of the subject does not change. The way we can incorporate parallax and implement a better, full 3D experience is by using holograms. At first, till the 1960's electrons were used to produce holograms and thereafter, light, since till then the laser had not been invented.

In photography, light bounces or scatters off the subject and the intensity of the light is encoded on the lens or photographic plate. The property of light duly left out during this process is phase [2]. Phase is the distance light has travelled from the object, which cannot be measured using a photograph but in a hologram you can, since the experimental setup to produce one is different.

A hologram works in the following fashion – First, light from a laser is divided into two separate beams - the reference beam and the object beam. The object beam is made to reflect off the object and produced onto a photographic plate. Further, the reference beam is reflected into the same plate thus causing interference pattern between both the beams, thus allowing us to capture the phase property of light. After this procedure, the hologram perceived by the naked eye is not an ideal one. The original laser light or an identical one must be shone into the plate made, thus allowing the reversal of the entire process. This enables recreation of the light that originally bounced off the object – thus creating a realistic virtual object, as if it is right in front of you! This is the process through which a still hologram is constructed. In simple words, a hologram is a sculptural casting of the light waves [3]. The simple working of a hologram has been illustrated in Figure 1.

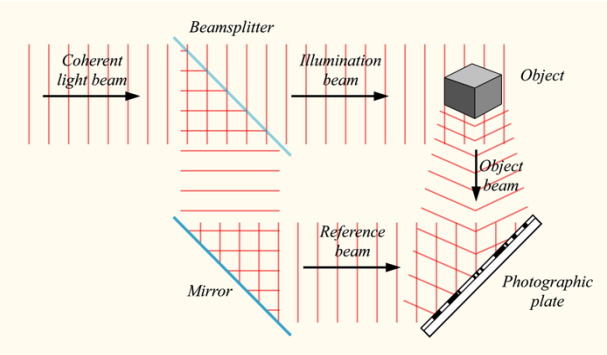

Figure 1. How a hologram works

4. APPLICATIONS

4.1 Real World Applications Today

With the use of high definition projectors, special effects and CGI animation, holograms are used for various applications. Instead of a real object's reflection appearing on a plate of glass, today, video, animation is directly shone onto a chemically treated film through a high power HD projector. This results in a distinct hologram projection. Holography enables the light field to be recorded and reconstructed. A very common application of holography is the use of holograms on credit cards, debit cards as well as membership cards. It provides added security to minimize counterfeiting [4]. Companies make good use of holography in fields such as advertising and marketing. Holograms are also useful in medical surgery and education. Recent real-world applications are listed in Table 2.

Table 2. Recent real world applications

Used in	Function
Big Brother, family reality show[5]	3D holographic projections of friends and family
Medical Devices, Pharmaceutical marketing[6][7]	3D medical animation without special glasses; including interactivity
The Movieum of London Museum[5]	Exhibition, retail displays, motion capture, interactive systems
360BrandVisionT [8]	Display suspended holograms that can be seen 360 degrees in any lighting environment – beneficial for advertisers

4.2 Microsoft HoloLens

Unveiled at the Microsoft's Windows 10 event, the HoloLens takes Microsoft into the world of mixed augmented reality. With this device, holograms can be mixed in your real world and 3D mapping is performed in real time.

It is made up of specialized components – the optical system that works in lock step with advanced sensors. The Holographic Processing Unit (HPU) processes a large amount of information per second – number of terabytes in real time. With the help of the HPU, the HoloLens understands gestures and where the individual is looking, thereby analyzing the environment [9]. Containing more computing power than an average laptop, it is passively cooled without fans. The hardware of the Microsoft HoloLens is shown in Figure 2. While Google Glass is not location informative, the HoloLens is the only portable device capable of doing so. It recognizes touch, surround sound without cables or any connection to a phone or the computer. Just imagine you can Skype with someone on your kitchen wall or even control a rover on Mars. The possibilities are infinite. There are some downsides to the device though. Manipulation is only possible by tapping; there is no other way of controlling the virtual world. The display requires proper lighting and the scope of application is dependent on apps, developers.

With the Microsoft HoloLens, the world is embracing reality in three dimensions. You can have your desktop where you want it, air tap to watch a video on YouTube, everything is handsfree – you say follow me and entertainment tags along.

Figure 2. Hardware Involved in Microsoft HoloLens

5. FUTURE

3D holographic projection has a promising future ahead. Smartphones have become necessary commodities for people. Today, holographic projectors are being made smaller and portable, thus raising a possibility that they may be incorporated into cell phones in the future. Flash memory could be replaced by holographic memory that would prove to be a benefit to smartphones and PDAs.

Holographic data storage could significantly increase the memory capacity of phones. Today, we can watch the television on phones, but since the screen is two dimensional, it does not provide an ideal experience. Imagine being able to project this TV screen onto the wall. This would transform the use of cell phones for visual media. Holography has tremendous scope for being applied to design. This applied science can be used for assembling electronics as well as displaying 3D models of molecules of biological structures. It can also be applied to product development, model building, construction and the apparel industry. Consider a situation where an automobile prototype built on the AutoCad software is projected as a hologram. With the features of manipulation, feedback and interaction, the design process would get a lot easier and efficient. Holography can also serve as a boon in the areas of telecommunication, presentation, communication, remote conferencing and distance education by replacing 2D screen pictures, introducing three dimensional, detailed and accurate representations through projection systems.

In future, holography can also be interconnected with devices like the camera, television, IPad, laptops, computers. Using this concept, you could have your PC on you palm or some memorable photographs on the wall of your home. One of the most useful applications of holograms in the future is in the medical field. Holotechnology imaging can enable doctors to view an artificially constructed, three-dimensional version of internal anatomic features of the human body. Surgeons can test their line of action through manipulation of 3D imagery before the actual operation, thus improving the chances of eventual success.

6. CONCLUSION

Holographic projections offer numerous advantages. They serve as high-resolution three-dimensional images that do not need any necessary structure for projection or any headgear or eyewear for viewing. The efficiency of this technology lies in the accuracy of holograms, life like images, an interactive display and an accommodating feedback mechanism. The potential of Holography as a technology is promising. Having been successfully used in various fields such as business, art and healthcare, the scope of application can be broadened to improve quality of life. It will change the way we view things in today's era. It will become a very integral part of human societies and civilizations in the future.

7. REFERENCES

[1] Ahmed Elmorshidy, "Holographic Projection Technology: The World is Changing" Journal of Telecommunications, Volume 2, Issue 2, May 2010

[2] Brit Lab- "How does a hologram actually work?" http://ns336220.ip-91-121-94.eu/download/3gpmp4aviflvcaduCx1ntBsJqE/How+does+a+Hologram+actually+work?++Sci+Guide+(Ep+3)++Head+Squeeze

[3] Chris Woodford, "Holograms" http://www.explainthatstuff.com/holograms.html

[4] "Holography-Current and Future Applications" www.math.ubc.ca/~cass/courses/m309-04a/chan/applications.doc

[5] James, Ryan (August 26, 2009). 3D Holographic Projection: The Future of Advertising? http://www.activ8-3d.co.uk/about-us/articles/3D-holographic-projection- technology.php

[6] New Medical 3D Holographic (Moa's) Used for Medical Devices Pharmaceutical Marketing. Medical and Scientific Animation. http://medical-animation-studio.com.

[7] Illustration Medical. Medical and Scientific Animation. Copyright 2008 Medical Animation Studio5105 Route 33 http://medical-animation studio.com/MedicalIllustrationMOAAnimation.html

[8] Newest Technology: 360BrandvisionTM Offers 3D Video Holograms in 360 Degrees. Las Vegas, NV (PRWEB) November 10, 2008. PR WEB Press Release. (www.prweb.com)

[9] Microsoft's HoloLens explained: How it works and why it's different http://www.cnet.com/news/microsoft-hololens-explained-how-it-works-and-why-its-different/